VENTED MEMBRANE-TYPE TOUCH PANEL

BACKGROUND OF THE INVENTION

The invention is a touch panel device which electrically indicates the X–Y coordinates of contact of an operator's finger on it and is sensitive to pressure only. Frequently, information is displayed on a substrate beneath the touch panel as well. The coordinates of a contact can be related to the displayed information thus providing for interactive communication between the operator and the device of which the touch panel forms a part.

The prior art includes a variety of techniques for sensing the location of contact on a surface. The most similar device of which the inventors are aware is the stretched drumhead type of membrane. This device employs a membrane spaced from a flat substrate and which can be deflected to cause conductors carried on it to contact those on the substrate. Another device is disclosed in an article entitled "CRT Touch Panels Provide Maximum Flexibility in Computer Interaction", Control Engineering, July 1976, pp. 33–34. This article discloses a curved flexible plastic sheet carrying small wires. The sheet can be deflected to cause these wires to come into contact with an orthogonal set of similar wires mounted immediately below. Spacers separate the sets of wires. U.S. Pat. No. 3,760,360 discloses a quite similar device embodied in a flat panel but having no capability of interactively displaying information. U.S. Pat. No. 3,495,232 discloses a somewhat simpler embodiment of a similar device. U.S. Pat. No. 3,921,167 discloses a panel location-sensitive to the approach of an external probe sensing change in capacitance.

BRIEF DESCRIPTION OF THE INVENTION

The touch panel covers a rigid substrate, whose face has a predetermined radius of curvature ranging from infinite (flat) to 25 inches or less, and comprises in part a resilient membrane of a contour conforming to the substrate face and attached about its periphery thereto. A group of discrete conductive strips adheres to the substrate on the surface facing the membrane. A second group of discrete conductive strips which flex with the membrane and which cross the first, is carried by the membrane on its surface facing the substrate. External pressure on a local area of the membrane forces one or more conductive strips on the membrane into electrical contact with one or more conductive strips on the substrate. By detecting which strips are in contact with each other, the approximate coordinates of the pressure point on the membrane can be determined. To prevent shorting between strips of each group when no external pressure is present, any one of several means can be used. In one embodiment, a thin, transparent insulating grid is interposed between the two groups of conductive strips. A piezoresistant coating on the surfaces of at least one group of strips also appears to function satisfactorily. When a curved substrate is used, a third anti-short means involves making the radius of curvature of the membrane somewhat smaller than the substrate's. It appears that the natural resilience of the membrane is sufficient to support the conductive strips carried by it spaced from the substrate's conductive strips with no interposed element.

In one preferred embodiment, the rigid substrate comprises a curved CRT faceplate or screen, with a

resilient membrane curved to conform to the CRT screen. The conductive strips both on the substrate and the membrane are sufficiently thin so as to be transparent and permit viewing of information displayed on the CRT screen. Being transparent, the conductive strips can be relatively wide with respect to the spacing between adjacent ones on the same surface and thus permit a larger area of contact. The anti-short means comprise an insulating grid preferably formed of one of several photo-resist polymers now available, thus allowing the grid to be formed in situ on either the substrate or the membrane by masking and exposing to light, followed by the appropriate chemical process. Such photo-resist materials at the small thicknesses contemplated are substantially transparent.

Accordingly, one purpose of this invention is to provide a passive surface sensitive to low pressure from a finger or stylus.

A second purpose is to provide a touch panel permitting the viewing of a display beneath it.

Another purpose is to provide a touch panel which can be easily integrated with existing display designs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a corner portion of a typical touch panel assembly, flat or curved, embodying the invention.

FIG. 2 is a cross section of a curved embodiment of the touch panel displayed in FIG. 1 and incorporating a membrane having a slightly smaller radius of curvature than the substrate.

FIG. 3 is a blowup of a portion of FIG. 2 detailing the relationship of the two sets of conductor strips and the insulating grid (when present).

FIG. 4 is a blowup of a portion of FIG. 3 showing in still greater detail the relationship of the two sets of conducting strips and the insulating grid.

FIG. 5 is a blowup of a portion of FIG. 2 employing a piezo-resistant anti-short means.

In all of these drawings scale between the various parts is not always consistent as this simplifies understanding. Suitable dimensions for the elements of the structure are set out below as needed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The corner portion of the preferred embodiment shown in FIG. 1 comprises a base or substrate **10** which may be flat or, as in FIG. 2, curved. Substrate **10** must have an insulating surface. Y conductive strips **20–24** comprise transparent coated areas firmly adhering to the surface of substrate **10** facing the viewer. In a typical application substrate **10** can at least partly comprise a CRT screen. It may not be convenient to directly apply conductive strips to a CRT screen or other substrate, but rather form them on a clear plastic sheet **55**, curved if intended to conform to a curved CRT screen, which is then glued or otherwise attached to substrate **10**. Leads **40–44** are attached to ends of strips **20–24** respectively so as to make electrical contact between them and external support electronics. In a typical device, each of conductive strips **20–24** is 0.5 in. (1.27 cm) wide and is separated from adjacent strips by 0.005 in. (0.0127 cm.) gaps. Strips **20–24** are in one embodiment preferably formed from indium oxide, tin oxide, or a combination of both oxides. The strips are easily formed by coating the entire face of substrate **10** with the conductive material using standard techniques. Standard